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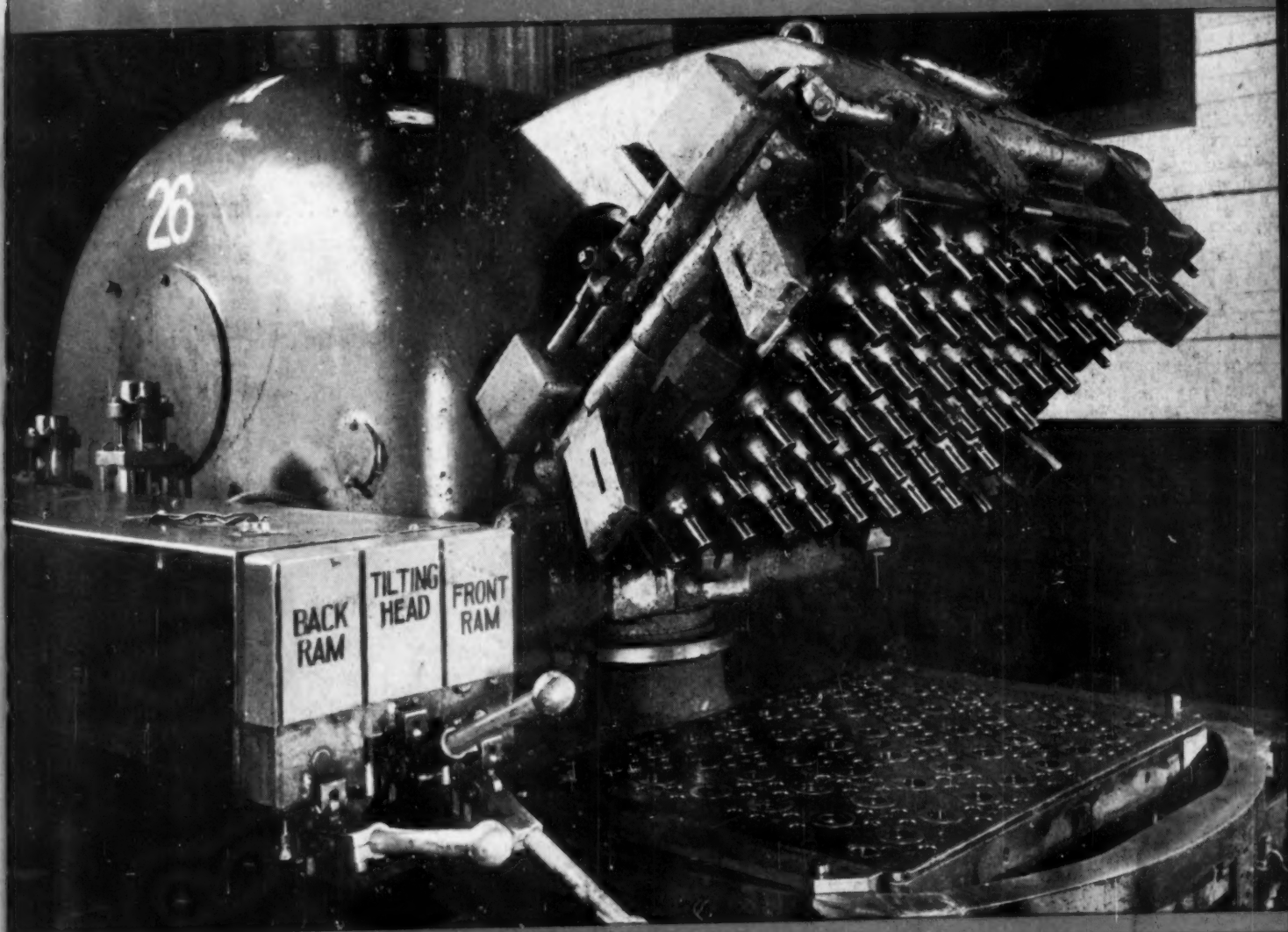
Applied HYDRAULICS

The Magazine of Hydraulic and Air Circuit Engineering



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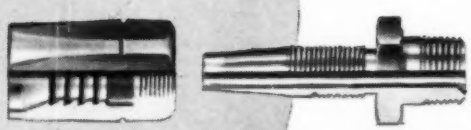
Aeroquip

HIGH PRESSURE HOSE LINES



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JANUARY, 1949

Vol. 1 No. 12

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Editor

R. W. ELMENTHALER
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Production Department
WILLIAM V. LINAS
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Circulation Department
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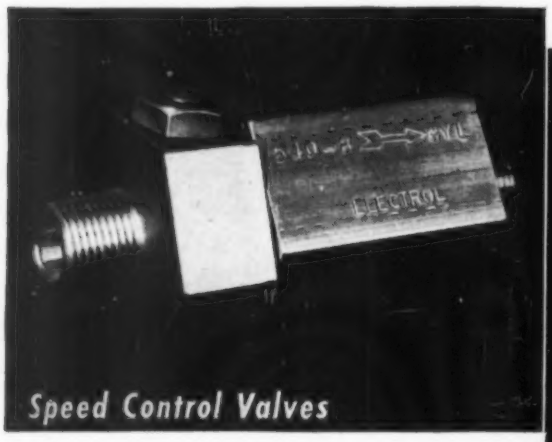

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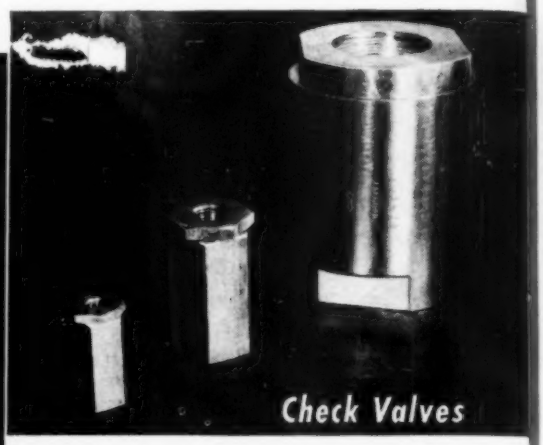

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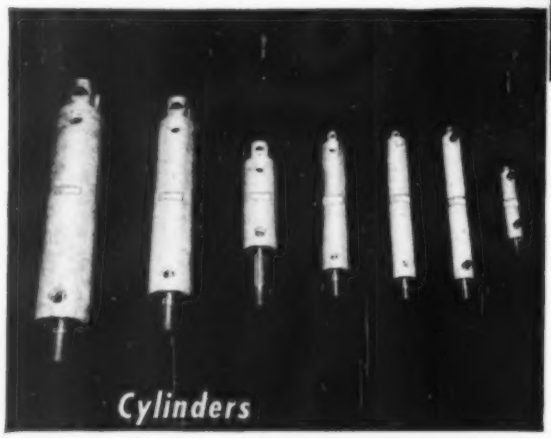

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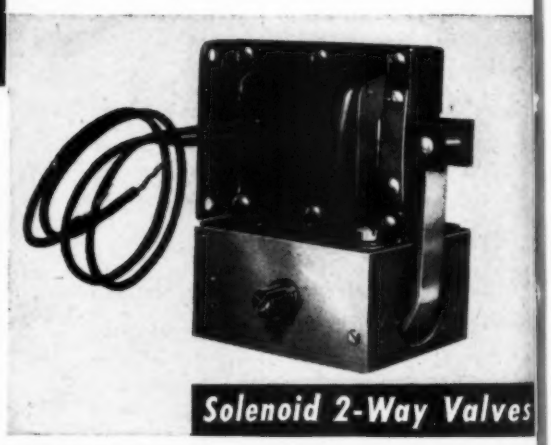

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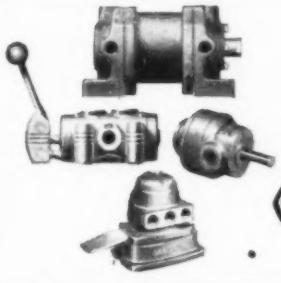

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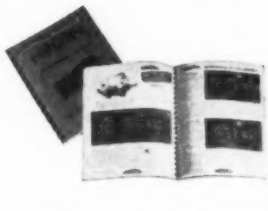

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An editorial on Americanism

WE CAN DEMAND . . .

Vast parking lots in which thousands of workers' autos are parked are nothing particularly new or exciting to the average American. We see such parking facilities next to nearly every plant all over the country. If such parking space—or at least *some* parking place—is not provided, the worker goes where there IS a parking place provided. Nobody's going to prevent Joe American from driving his car to work. No sir, this is America.

> ***I was particularly impressed by the hundreds of bicycles parked in lean-to sheds outside of plants in England, France, and Italy. I was much impressed by the number of bicycles on the streets in those countries. On a week end, thousands of tandem bicycles are ridden by men and their girl friends, pumping, sweating and working to get out into the country for a small holiday. They're glad to work for THEIR holiday.***

Step into a phone booth. Close the door and be in a soundproof, private chamber. Call your wife or your mother or your office. Phones here are everywhere. Just drop a nickel, dial and get your number. Want to call long distance? Sure thing. Just charge it to your bill and pay it at the end of the month. You'll get your party in the distant city without even taking the receiver from your ear. Get the wrong number occasionally? Have a slight delay? By gosh, the phone company can't do that to you. You'll write to your Congressman or something. No sir, you're an American. Where does the phone company get that stuff, anyhow? By golly, you'll see about . . . . and yakety, yak.

> ***Let's make a phone call in Marseilles - or Rome - or even London. It's a production. It's an epoch. It's terrific. Want to talk to a near-by town - say 50 miles away? Two to three hour delay. Want to make a local call? On some blocks in a big European city there might be a store with one single phone. If the storekeeper happens to feel good he'll let you use his phone. Granting that you get your number by the fifth try, you can then talk to your wife or your girl or your office, right out in the middle of the room or - as so often happens - out on the sidewalk with all the traffic honking by.***

We DEMAND good telephone service, our own automobile, our own homes, our radios, electric lights, bathrooms, showers, super markets and baseball games. We have come to feel that it is the inalienable right of every American to have these and more—because he IS an American.

> ***The French worker, the English worker, the Italian, the Belgian work longer hours, work harder and for a much lower standard of living and many fewer living comforts than we. They can not DEMAND - they're glad if they just get food.***

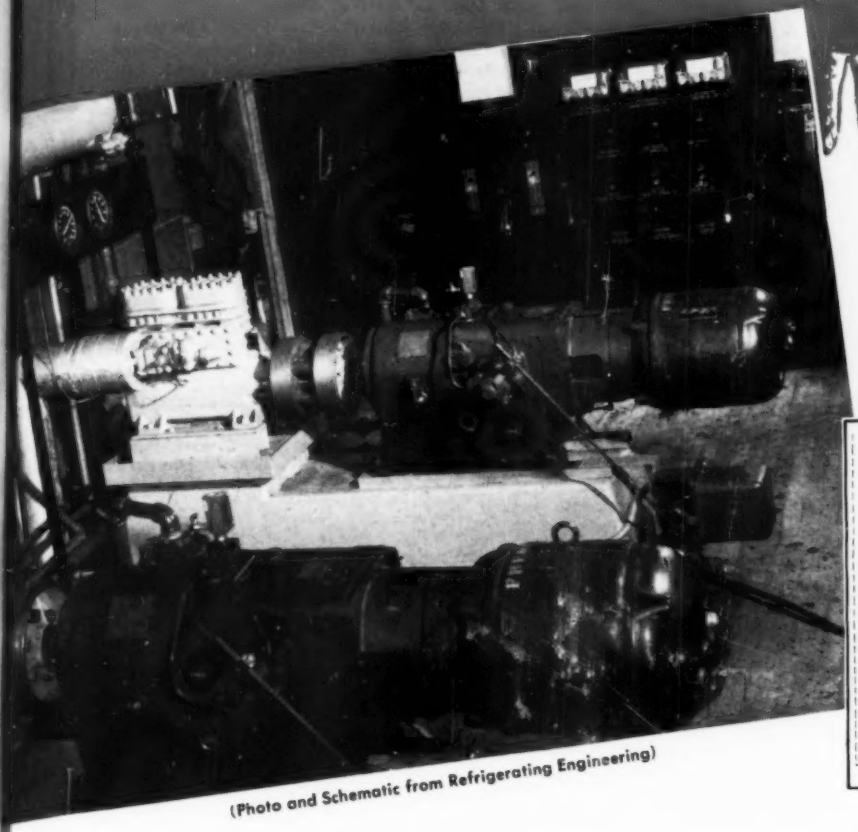
We shouldn't forget that the system which built our great country and our great way of life has yet to be equalled anywhere else. The soap box orator (the one with the holes in his pants) rants and raves and tells us how things could be improved, if only we followed the system used in certain foreign countries. That has, as yet, not been demonstrated. We are fed a lot of stuff which purportedly comes from behind "the iron curtain". Actually, it is only high-sounding "stuff". No one has seen, anywhere in this world, the equal of what we have here in America. Let's continue to demand it—but protect it and *work* for it.

Irving B. Hexter

Publisher

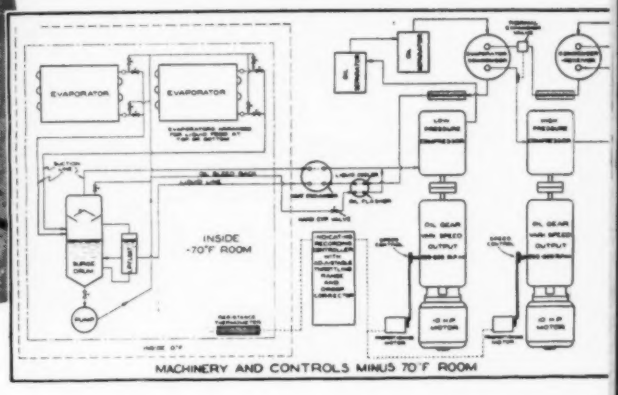
A STEADY 102° BELOW FREEZING

. . . CALLED FOR CONTINUOUSLY VARIABLE SPEEDS AND STABLE OUTPUT TORQUE



(Photo and Schematic from Refrigerating Engineering)

Two Oilgear Fluid Power Transmissions driving compressors for research laboratory's —70 degree testing room. (Other Oilgear Transmission drives compressor for 0 degree room.) Output speed of transmissions varies according to temperature differential upon resistance thermometers. Control of speed is entirely automatic. Manual control for starting is optional. Oilgear Fluid Power Drives and compressors operate continuously. (See schematic below).



MACHINERY AND CONTROLS MINUS 70°F ROOM

OILGEAR *Fluid Power* SOLVED THIS PROBLEM

The wide range of installations that demonstrate the reliability, scope and ease of control of Oilgear Fluid Power Drives and Transmissions grows daily. A case history from REFRIGERATING ENGINEERING, official journal of the American Society of Refrigerating Engineers, telling how a research laboratory chose Oilgear Transmissions and obtained continuous, dependable performance without delay, is another chapter in that story.

Demands for tests of materials at extreme temperatures called for equipment able to hold testing room temperatures stable at all times—usually at 70° F. below zero. It also had to refrigerate test materials as rapidly as possible. This meant a system of varying compressor speeds automatically—so as to compensate for variations in heat load.

Previous experience had shown that . . . the use of direct current motors, or variable speed drives of the belt-and-pulley type, under automatic control, was not entirely reliable and required considerable servicing.

Then Oilgear Fluid Power Transmissions were adopted. These transmissions provide continuously and automatically variable output speed and maximum output torque at all operating speeds. Nearly two years' experience reveals that temperatures have been maintained within ±½° F. of the desired figure over long periods of time, that no attendant is required except for a few minutes' daily routine inspection, that the Oilgear drives are completely reliable.

Thus the evidence grows that if you are tired of machine or process drives and transmissions that don't stand up, if you want simpler, better, more productive and dependable drives, if you have problems not yet solved, it will pay you to contact Oilgear Fluid Power engineers. THE OILGEAR COMPANY, 1564 W. Pierce St., Milwaukee 4, Wis.

Oilgear Fluid Power

PUMPS, MOTORS
TRANSMISSIONS, CYLINDERS AND VALVE

When man first plowed with a crooked stick he controlled it manually. When the walking plow came, the plowman guided it with its two handles and kept it at the proper depth in the ground. Riding plows were mounted on wheels and were provided with depth adjustment levers which the operator could set to suit conditions. Tractor plows were provided with similar levers, which could be adjusted from the operator's seat. Gravity and the "suck" of the plow caused the plow bottoms to enter the ground when the levers were released; however, this required the operator's manual strength applied to the levers to bring the bottoms above ground at the furrow's end.

To ease that burden of lifting, engineers designed the mechanical ground drive power lift, which could be operated with the pull of a cord. Power lifts were applied to plows, field cultivators, hay rakes and other implements and machines. For a time the combination of power lift and depth adjustment or positioning levers seemed to answer requirements.

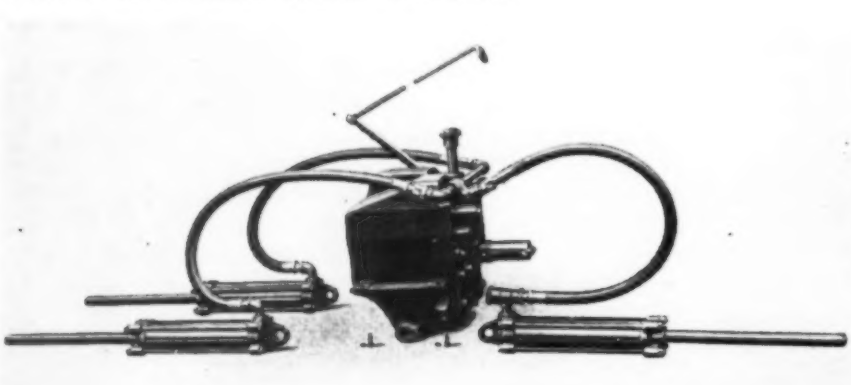
But not for long. More and more farm equipment engineers and many operators felt the need of a smoother, simpler, faster, more flexible and more effective control of the operated equipment. In their search for something better they turned to hydraulic power.

Hydraulic Circuits FOR FARM TRACTORS

This paper was very favorably received at the last National Conference on Industrial Hydraulics. While Mr. Ziskal points out the safety, ruggedness, good appearance and reasonable cost factors of hydraulic control mechanisms for farm equipment, there was almost universal agreement with him that the simplicity of the circuits, with ordinary maintenance well within the ability of the average tractor farmer, is a critical factor in extending hydraulic unit applications.

By JOSEPH F. ZISKAL
Product Engineer—Hydraulics Farm Tractor Engineering Department
International Harvester Company
Chicago, Illinois

Fig. 1. Assembly of hydraulic elements of a "delayed lift" system for forward and rear mounted implements on cultivators.



THE APPLICATION OF HYDRAULIC power to the control of farm equipment has passed through a number of evolutionary stages. The first hydraulic circuit consisted of a pump, a safety valve, a reservoir, a control valve and a cylinder connected to the valve with hoses. The system had no by-pass and kept operating at about 300 psi. This, of course, wasted engine power, heated the oil and lowered the efficiency of the pump to a point where the system would become inoperative.

Engineers then concentrated on means of relieving the pressure on the oil during the non-working cycle in order to maintain a low temperature and high efficiency. Numerous methods were devised, such as a separate by-pass valve, an open-center type valve, disengagement of the pump, blocking of the pump intake and the use of a variable displacement pump which did not pump during the non-working periods. With the oil temperature kept at a minimum during the by-pass cycle, it was possible to use higher working pressures. Prior to World War II, many systems were working at 800 to 1000 psi.

A good example of this type of system is the hydraulic circuit, the "Lift-All", standard on the Farmall "H" and "M" tractors. Figure 1 shows the component parts of such a system. A noteworthy feature is known as "delayed lift". It is used principally with forward mounted and rear mounted cultivators. As the tractor comes to the end of the crop row, the operator moves the control lever and the forward mounted gang is lifted out of the ground immediately. Lifting of the rear mounted gang is delayed just long enough to let it finish cultivating the row. When the tractor starts into a row, the action is reversed. The forward mounted gang enters the ground first, followed by the rear mounted gang a second later.

Operation of the Circuit

Figure 2 shows the Lift-All system with the control lever in the neutral position. This is the by-pass position of the unit which permits the oil to return to the reservoir under light pressure, thus keeping the oil relatively cool, although the pump continues to run. The system can be operated when the tractor is in motion or when the gearshift lever is in the neutral position, inasmuch as the pump drive is taken back of the engine clutch.

Figure 3 shows the control lever in the raising position,

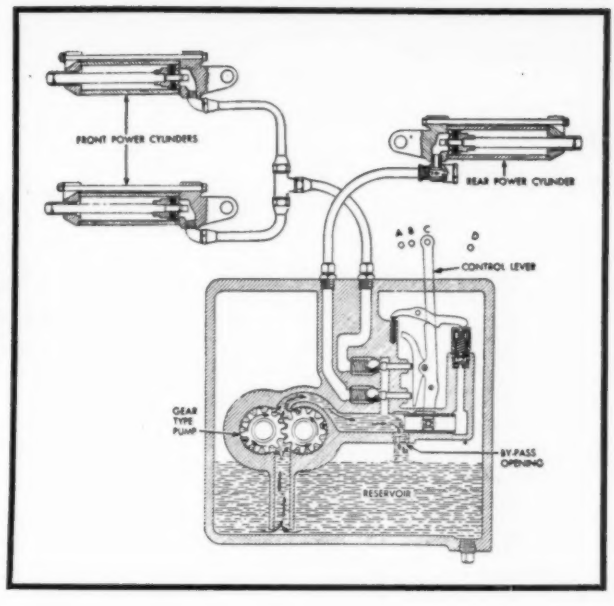


Fig. 2. A "delayed lift" circuit in the neutral "C" or by-pass position. Oil is returned to the reservoir under light pressure, allowing continuous pump operation without heating up the oil.

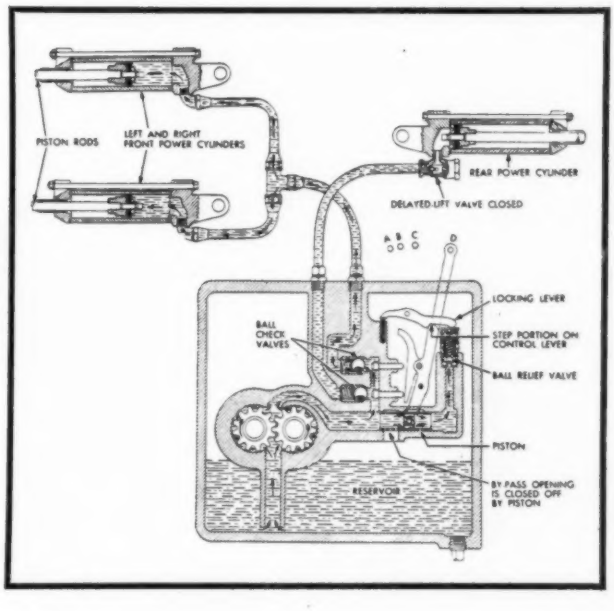


Fig. 3. The control lever is moved to "D", the raising position, and held by the locking lever. The piston closes the by-pass, the oil opens the ball check valves, actuating the front power cylinders.

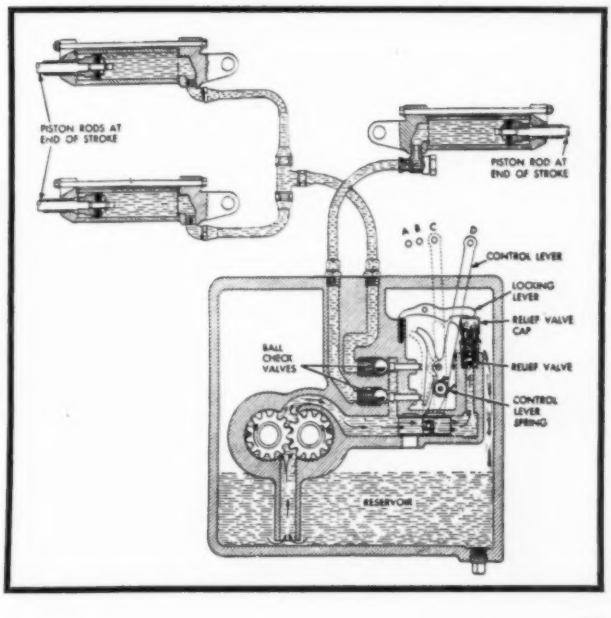


Fig. 4. The delayed lift valve opens when the front cylinders have completed their stroke or when pressure reaches 500 psi, permitting the rear cylinder to fill. Oil pressure then opens the relief valve, raising the locking lever and returning the control lever to neutral.

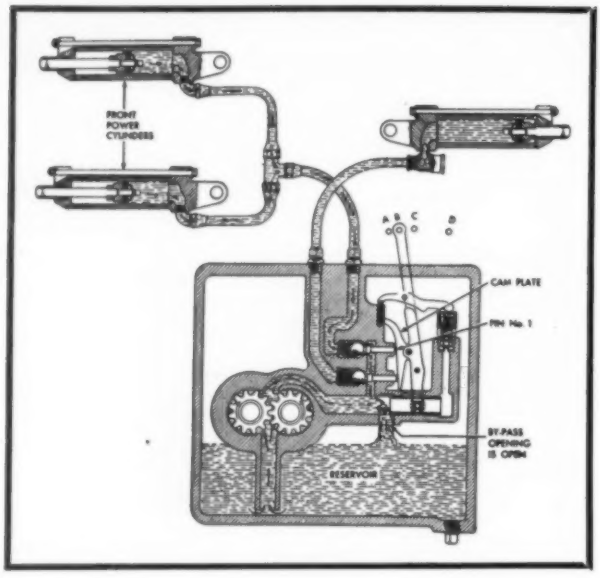


Fig. 5. When the control lever is moved to "B", pin No. 1 on the cam plate releases the ball check, opening the front cylinders to reservoir. Moved to "A", pin No. 2 functions similarly to open rear cylinder to reservoir.

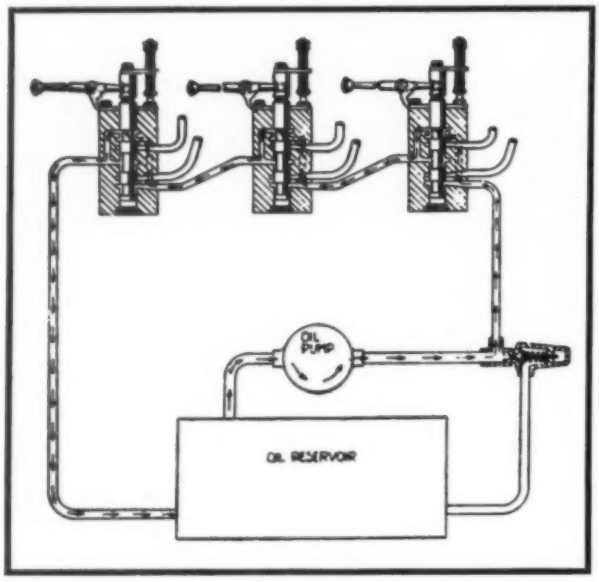


Fig. 6. Valves in open center by-pass position.

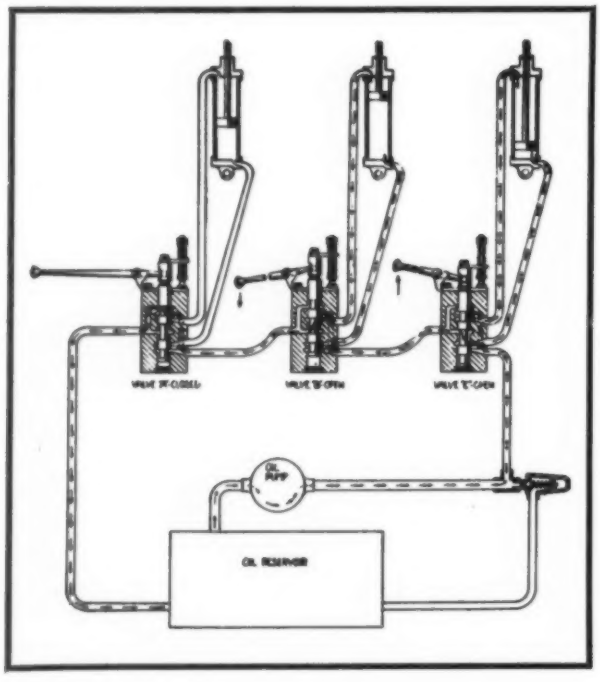


Fig. 7. Cylinders operated by valves "A" and "B" are in parallel with cylinder operated by valve "C" and operate as slave cylinders.

"D". It is held in this position by the locking lever, which drops into a step portion on the control lever. With the control lever in this position, the piston closes the by-pass opening and the oil, under full pressure, opens the ball check valves and flows to the front power cylinders. As soon as the front power cylinders have completed their stroke or, for some other reason, the pressure builds up to 500 psi, the delayed lift valve opens, allowing oil to enter the rear power cylinder.

In Figure 4 the front cylinders have been filled and the oil pressure, having risen above 500 psi a moment later, has forced open the delayed lift valve, allowing the rear cylinder to fill. The slight delay in filling the rear cylinder permits the front section of the cultivator to rise first, which is what the operator desires as he comes to the end of the row. When the rear cylinder is filled, the oil pressure pops the relief valve cap and raises the locking lever. This, in turn, releases the control lever latch and the system goes into a neutral position, with the check balls holding the cylinders full.

Figure 5 shows the control valve moved to position "B". In this position the ball check is released, allowing the oil to flow from the front cylinders to the reservoir. In this position the cam plate impinges on pin No. 1 but does not actuate pin No. 2 in the rear power cylinder line. By moving the control lever to position "A" (not illustrated), the cam plate pushes against pin No. 2, releasing the ball check holding the oil in the rear cylinder. The working pressure of this system is 750 to 800 psi.

The recent war accelerated developments in hydraulic pumps, seals and hose to a point where pressures up to 3000 psi could be safely used. The doughnut or "O" ring type of packing was developed to ease the seal and gasket problem.

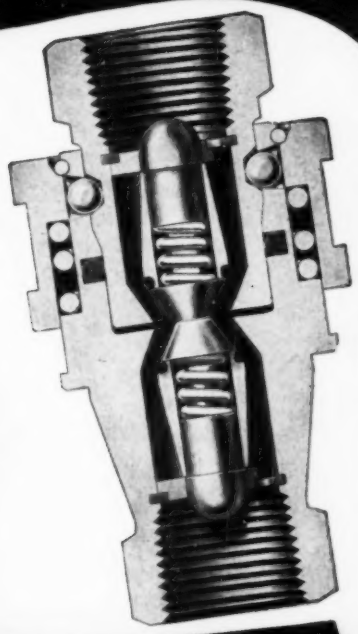
A commonly used hydraulic circuit has a gear pump mounted

(Continued on page 18)

"NEW" FOOLPROOF

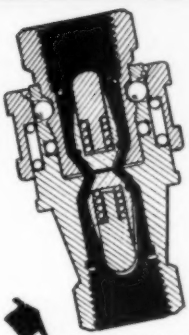
HANSEN

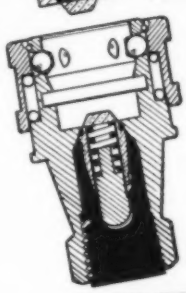
HIGH PRESSURE 2 WAY SHUT-OFF COUPLINGS



SEALS BOTH ENDS OF LINE AUTOMATICALLY INSTANTANEOUSLY

Red section shows how torpedo type valves contact valve seats in both socket and plug to provide instant seal of fluid in both ends of line.





Identical torpedo type valves in socket and plug are mounted to permit free flow of gas or liquid through connected coupling.

Hydraulic and pneumatic lines can be quickly, easily, and safely connected or disconnected with the Hansen High Pressure Two-Way Shut-Off Coupling—with both ends of line positively sealed when coupling is disconnected.

To connect, you merely pull back sleeve and push plug into socket. Identical torpedo type valves in plug and socket are mounted to permit free flow of gas or liquid when coupling is connected.

To disconnect, just pull back sleeve—coupling immediately disconnects, valves automatically and instantly seal both ends of line.

Plugs and sockets furnished with ½" Female Pipe Thread connections.

CAN BE AUTOMATICALLY DISCONNECTED TO PROTECT FLUID LINES

For applications where fluid lines would otherwise be damaged by sudden strain, the Hansen coupling can be mounted in a stationary bracket to pull back sleeve and disconnect coupling instantly and automatically—leaving fluid lines free, positively sealed, and—undamaged.

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QUICK CONNECTIVE FLUID LINE COUPLINGS . . .

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AIR CONTROLLED PAPER SLITTING

A novel air circuit applied to the control of paper machine slitter blades that has increased production, made the operation fool-proof and protected both operator and machine from performing any function out of the proper sequence.

By E. W. CLEM
Chief Engineer
Rice Barton Corporation
Worcester, Mass.

ONE OF THE LAST OPERATIONS in the manufacture of paper is the slitting and winding of the finished rolls of paper. We will describe a novel air circuit used that speeded up the slitting operation, made the normal operation completely fool-proof and insured that each of the functions was performed in its proper sequence, protecting operator and equipment alike.

Figure 1 shows the front or loading side of the slitter and winder. The paper enters over the large rolls, under the first and over the second, across a horizontal feed table surface and over the lower motor-driven slitter blades. With the exception of the two edge slitters, the top set of slitter blades is raised out of contact for the threading up operation which consists of threading one full width of paper around the winder bar. As soon as tension is produced in the sheet, the top slitter blades are lowered, off side in relation to the lower slitting blades. The actuation of the cylinders moves the blades into contact with the bottom slitter blades, resulting in a shear-type cut in the paper.

The top slitter blades are spring-loaded in order to create an edge tension against the bottom blades. For this reason the top blades cannot be lowered radially because the blade would strike directly on the lower blade.

The air circuit is designed to displace each top slitter blade laterally, permitting the accurate, precision contact of the top and bottom blades for the shear cut. The top blades must be displaced away from the bottom blades before the master cylinder can rotate the entire top slitter assembly.

The master cylinder, manually controlled by a master valve, is a double acting 6 in

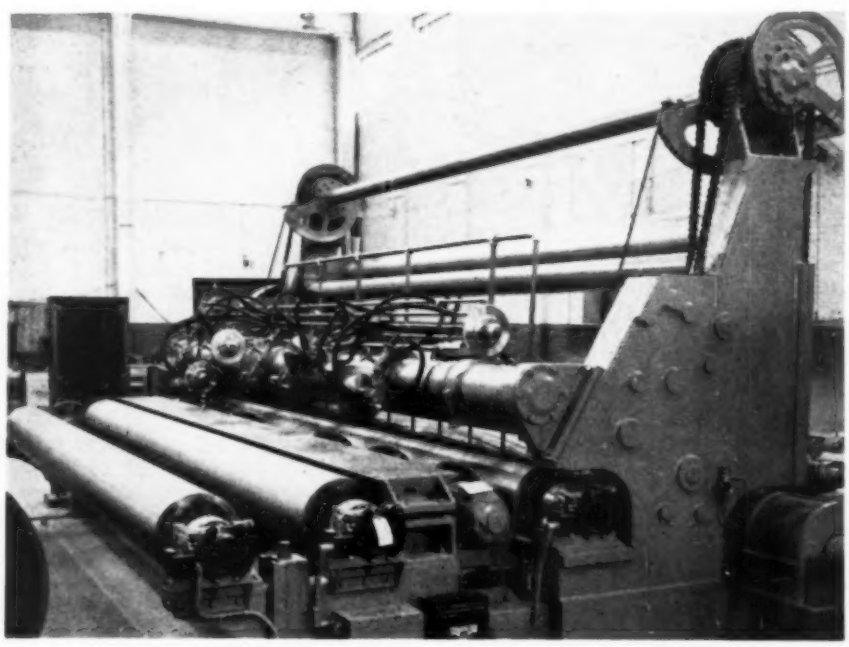

Fig. 1. The paper slitter and winder is shown unloaded with the top slitter blade assembly raised. The master valve for rotating the assembly is on the far end.

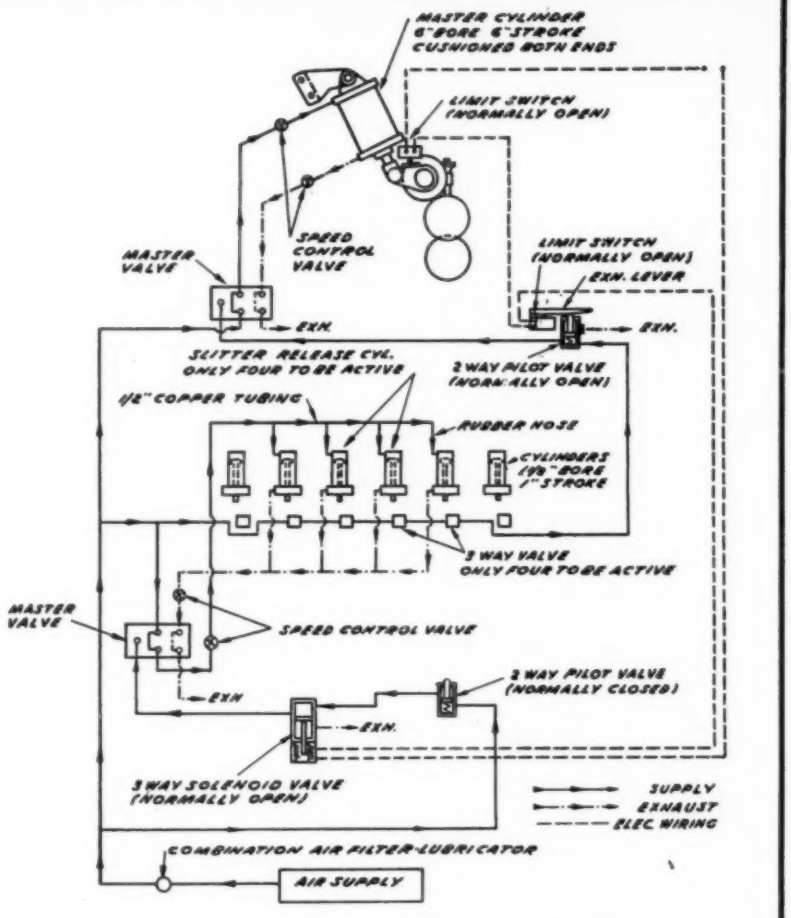

Fig. 2. Schematic plan of the air circuit. A field change was made in the upper pilot valve, a heavy spring was placed under the poppet to keep it closed when air pressure was admitted to the center of the valve. This required a rearrangement of lines to and away from this valve.

bore, 6 in stroke air cylinder, with speed control valve on both strokes. The master cylinder is prevented from exhausting by a limit switch and a 2-way pilot valve (upper right on the circuit diagram), both normally open. By depressing a lever, (see diagram) connecting this switch and valve and holding it depressed until the slitter blades separating cylinders have returned to their normal out position, the master cylinder is exhausted and the top blade assembly moves down to the offset position.

Each of the top slitter blade units has its own air cylinder which actuates to move the top blade into cutting position with the bottom blade. A spring mounted on the back side of the blade provides the proper edge tension for the slitting. The operator initiates the action of the blade separating cylinders by depressing the stem of the normally closed pilot valve. Master actuating and speed control valves, identical with those that control the large master cylinder, are used. Any four of the six slitter cylinders may be used at one time. This gives the necessary flexibility to the widths of paper to be slit.

Flexible hose connections are used to and from each top slitter cylinder and the rigid copper tubing mounted to the rear of the machine. Individual three-way valves are connected in series from the main air supply line and two-way pilot valve. The action of these valves, by delaying the reversal of the large master cylinder until the individual blade cylinders have retracted, is a safety feature that insures the proper sequence of operation.

The winder unit shown in Figure 1 is 196 in wide and operates at a paper speed of 4000 feet per minute. Magnetic brakes shown on the ends of the free turning rolls were added to check free coasting and stop the rolls quickly in case of web break or for starting new roll.

Before the air circuit was worked out, it had been necessary for the operators to cross the machine on a foot walk and relieve the spring tension on each of the single slitter blades every time a roll was started. At the speeds used, this meant a slow, manual operation to relieve slitter tensions every fifteen or twenty minutes, twenty-four hours a day.

The air cylinders with standard, relatively simple controls to provide fool-proof sequencing, have solved a problem that was very troublesome in the paper making industry. A patent has been applied for on the circuit as described.

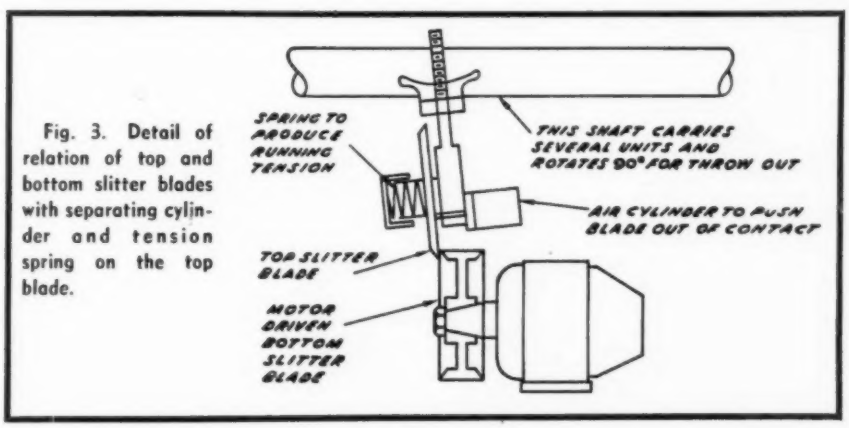

Fig. 3. Detail of relation of top and bottom slitter blades with separating cylinder and tension spring on the top blade.

HYDRAULIC CIRCUITS FOR FARM TRACTORS

(Continued from page 14)

on the engine and is driven from the front timing gears. A manifold is connected to the reservoir. The reservoir has a high pressure communication to the control valve, which is of the open-center type. The control valve is connected by hoses to the double-acting cylinder, which is of the depth control type. The oil circulates through the center of the valve and back to the reservoir during the by-pass cycle. When the valve is moved up or down, the oil is directed to one side or the other of the piston in the cylinder, exhausting the oil from the opposite side. The control valve is self-centering and the instant the hand lever is released the valve moves to the neutral position, holding the oil locked in the cylinder and by-passing the oil from the pump.

The operating position of the implement is controlled by means of the adjustable hydraulic stop valve. This valve, which is in the cylinder, is open while the oil is being forced into the large or left side of the piston. When the piston is being retracted into the cylinder, the stop valve limits the length of piston stroke in accordance with the position of the adjustable stop valve actuator on the piston rod. It is also possible to use a mechanical stop on the cylinder for implement control. In this system the pump, reservoir and control valve are mounted on the tractor and the cylinder is mounted on the trailing implement. To protect the hoses in case the hitch breaks or is released, a self-sealing breakaway type of coupling can, and normally is, used.

The circuit shown in Figures 6 and 7 is interesting, inasmuch as the pistons in any number of cylinders can be moved at the same rate, regardless of unequal loads imposed on the piston rods. Figure 6 shows three valves in the open center by-pass position. The movement of any one valve, up or down, causes a corresponding movement of the piston in the cylinder which it controls. When simultaneous operation of two or more cylinders is required, it is necessary to move all valves. This causes the pistons in the cylinders to move at the same speed. Figure 7 shows the second and third cylinders operating as slave cylinders, deriving their power from the first cylinder. This may have some disadvantages, but there are also advantages, since in the conventional system with two or more cylinders in parallel, the cylinder with the smaller load always moves first.

As a postwar project, International Harvester developed a new hydraulic system for the operation of direct-mounted implements. This system was designed to lower the implement under power as well as raise it, and to hold it automatically in whatever position the operator set it. With its selective control feature, it has been especially valuable in cultivating point rows, crossing grassed waterways, working in small fields and in soil conservation terracing, where change of implement position is frequent.

This system, which is called Touch Control, has the following features:

(1) It consists of one major unit comprising two double-action cylinders, each connected to a rockshaft with a power arm on each side of the tractor and mounted amidship on the tractor.

(Continued on page 20)

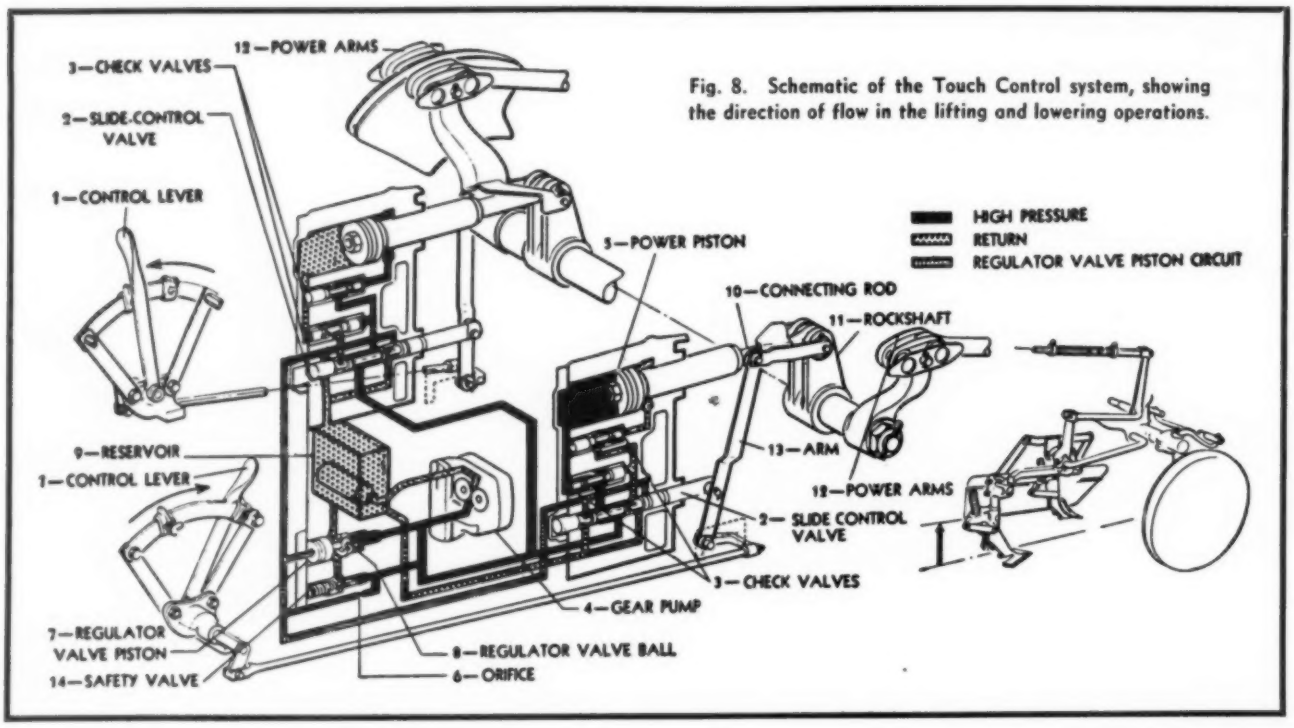

Fig. 8. Schematic of the Touch Control system, showing the direction of flow in the lifting and lowering operations.

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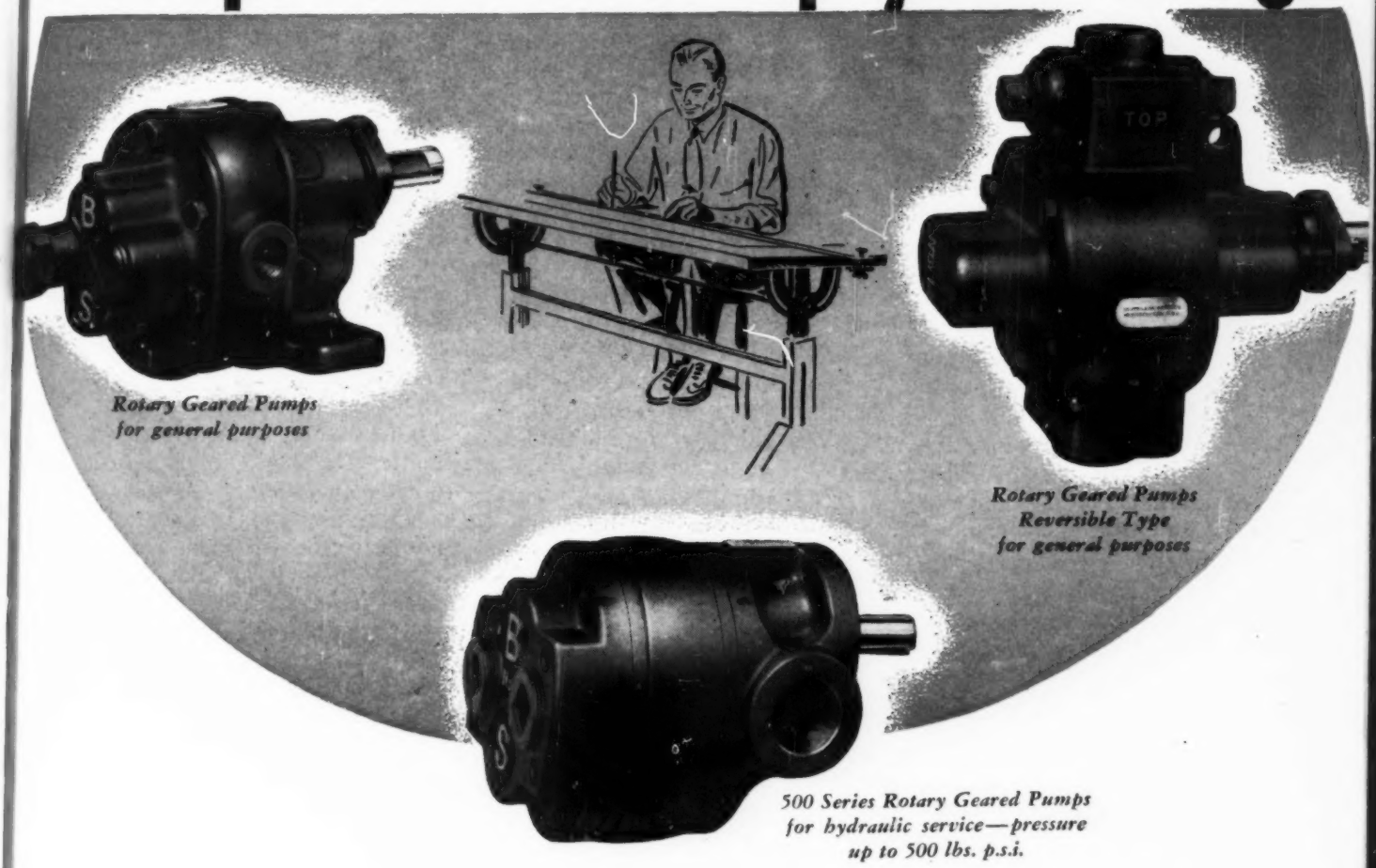

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500 Series Rotary Geared Pumps for hydraulic service—pressure up to 500 lbs. p.s.i.

YOU'VE MADE SURE of everything about your machine design . . . including lubrication, coolant supply and hydraulic service. Now make sure that the pumps you specify back up your design—specify Brown & Sharpe Pumps.

Everything about these pumps . . . design, materials and manufacturing . . . is the result of long experience in fulfilling the pump requirements for machine tools and other machine equipment. The aim of Brown & Sharpe in making this complete line of pumps is to provide the correct type of service, a completely dependable service and an enduring service for every pumping need.

Write for pump catalog which gives detailed specifications on the complete line of Rotary Geared, Vane, Centrifugal and Motor Driven Pumps. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

BROWN & SHARPE PUMPS B·S

HYDRAULIC CIRCUITS FOR FARM TRACTORS

(Continued from page 18)

(2) The pump is mounted on the engine, making the hydraulic power available whenever the engine is running, regardless of the position of the clutch.

(3) It is fast, providing a full throw of the power arm in one second and enabling the operator to control the implement almost instantaneously and thus keeping both hands on the steering wheel while turning.

(4) It will lift about 2000 pounds through an 8 in stroke and will hold the load indefinitely.

(5) It is a follow-up system, requiring only finger tip effort on the control levers, regardless of load.

(6) There are no hose connections anywhere in the system.

(7) It provides power control for any operating position of the implement at all times.

Figure 8 is a schematic drawing of the Touch Control with direction of flow in the lifting and lowering operations indicated. In the neutral position when the engine is running and the control levers (1) are stationary, the two slide control valves (2) block the passages from the pump (4) to the check valves (3) and to both sides of the power piston (5). As soon as the engine starts, the oil from the pump starts to apply pressure on the system. Since the passages are closed to the power pistons (5), pressure is applied through the regulator valve orifice (6) on the regulator valve piston (7) circuit. A slight pressure (32 psi) moves the regulator valve ball (8) off its seat and opens up a free passage for the oil to flow through the valve. The oil is then by-passed directly to the reservoir (9). Since the regulator valve piston (7) has four times the area of the valve ball (8), it opens easily and holds the ball off its seat. The oil circulates in this manner until one or both of the control levers are moved.

In the lifting operation, Figure 8, the forward movement of the lower control lever (1) moves the side control (2) forward. This opens passages for three circuits of oil:

(a) The regulator valve piston (7) circuit is free to flow into the return oil circuit which instantly relieves the pressure on the regular valve piston (7) and causes the regulator valve ball (8) to seat. A small quantity of oil passes continuously through the regulating valve orifice (6) and by-passes to the oil reservoir (9).

(b) The oil from the pump (4) now pushes the first check valve (3) off its seat and applies the necessary pressure (up to 1200 psi) on the head of the power piston (5).

(c) The instant the pressure starts to build up to move the power piston (5), this pressure also moves the actuator piston in the upper check valve (3) and forces the valve off its seat. As the power piston (5) is moved, the oil previously locked on the back side of the piston now flows back to the oil reservoir (9).

The piston (5) starts to move the instant the control lever is moved. As soon as the control lever is stopped or reaches a preset position, a response mechanism, consisting of a beam type arm (13) connected to the slide control valve (2) and the rockshaft (11) returns the slide control valve (2) to the neutral position when the piston (5) has moved the distance corresponding to the movement of the lever (1). The check valves (3) then automatically return to their seats and positively lock the piston (5). Simultaneously, the regulator valve piston (7) opens the regulator valve (8) which again permits the oil to by-pass to the reservoir.

In the lowering operation, the control lever is moved to the rear. This moves the slide control valve to the opposite direction and reverses the flow of oil to the power piston. Pressure is applied to the opposite side of the piston, which forces it back into the cylinder and permits the oil on the other side to return to the reservoir.

A safety valve (14) is provided for protection against excessively heavy loads. The valve opens at 1200 psi. The control levers can be moved slowly a short distance and stopped anywhere on the quadrant to obtain precision operating adjustments. Or they can be moved quickly all the way forward or back to lower or raise implements instantly. When the system is in neutral and control levers are stationary, oil is trapped on both sides of the power piston by the check valves (3), firmly holding the implement in any position.

Safety, simplicity, ruggedness and good appearance—all are important considerations in farm machine design, but we must also remember the cost. In our efforts to ease the farmer's chores, we should not develop equipment which must be priced beyond his reach. We must hold hydraulics for farm applications to a practical design, in which safety, low first cost and reasonable maintenance cost are prime considerations. It is safe to predict that in the not-too-distant future hydraulic control mechanisms will be applied to the operation of every major piece of farm machinery.

From a paper presented at the 1948 National Conference on Industrial Hydraulics, October 1948. Papers are available in bound form by addressing Mr. S. F. Musselman, National Conference on Industrial Hydraulics, Technology Center, Chicago 16, Ill.

THE REGENERATIVE CIRCUIT

By KENNETH COURT

THE REGENERATIVE CIRCUIT IS often used to obtain an unusual combination of speed and force with a single end rod, double acting cylinder. A common application is to obtain uniform rate of motion and force in both directions with this type of cylinder. This circuit can also be combined with other valving to provide a rapid advance, feed and return with a single fixed displacement pump.

The function of a regenerative circuit is usually understood; however, calculation of rates of motion, forces and flows through various parts of the circuit are difficult to determine.

The diagrams, Figures 1 and 2, were devised to illustrate the flow in the circuit and the formulas indicate conditions for various functions in the circuit.

A very simple device has been used in Figure 1 to indicate the conditions of flow. As the pressure will be equal in both ends of the cylinder, the effective area will be the area of the cylinder rod. Since oil displaced from the rod end will fill an equal space in the head end the volume delivered by the pump acts on the rod area. Note that the capacity of the valves must be sufficient to pass a flow equal to pump delivery (V) times the bore to rod ratio (K).

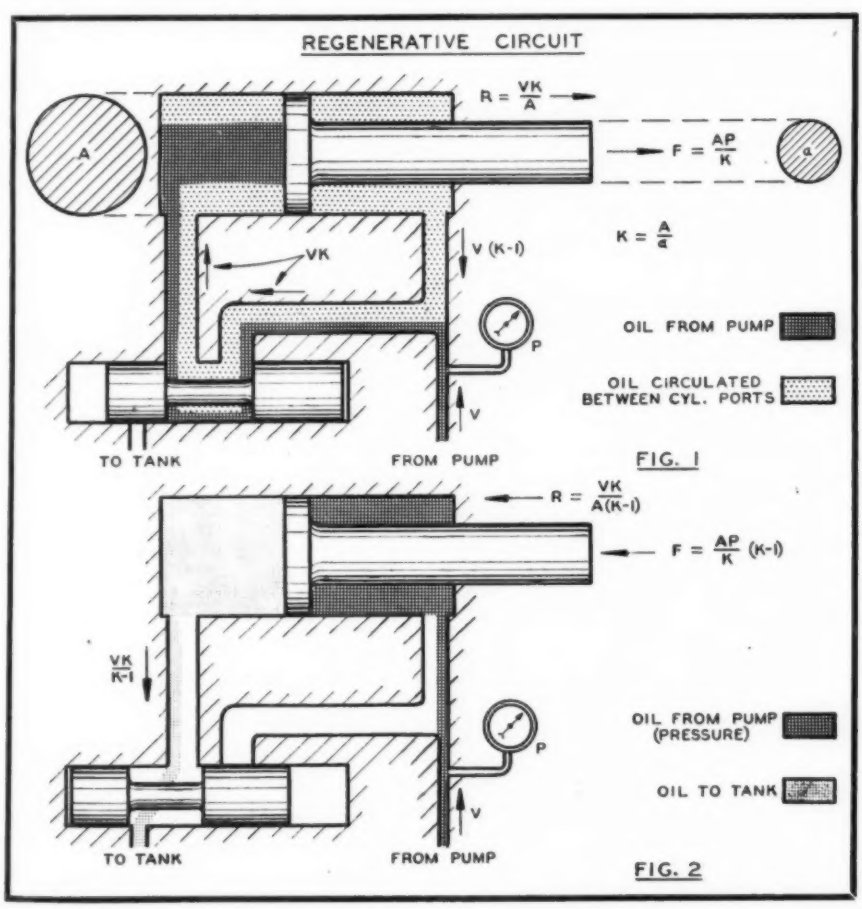

Figure 2 shows a conventional return and requires no further explanation.

By substituting 2 for K for the common application, i.e., the area of the bore is twice the area of the rod, the formulas prove that the force and piston speeds are equal in both directions of travel:

$$R \text{ (forward)} = \frac{2V}{A} \quad \text{(Fig. 1)}$$

$$F \text{ (forward)} = \frac{AP}{2} \quad \text{(Fig. 1)}$$

$$R \text{ (return)} = \frac{2V}{A(2-1)} = \frac{2V}{A} \quad \text{(Fig. 2)}$$

$$F \text{ (return)} = \frac{AP(2-1)}{2} = \frac{AP}{2} \quad \text{(Fig. 2)}$$

The application and operation of the regenerative circuit is very troublesome to many persons working with hydraulic circuits. The presentation herewith was developed to clarify this problem to classes at our hydraulic service school.

ROPER Hydraulic Self-Lubricating Principle

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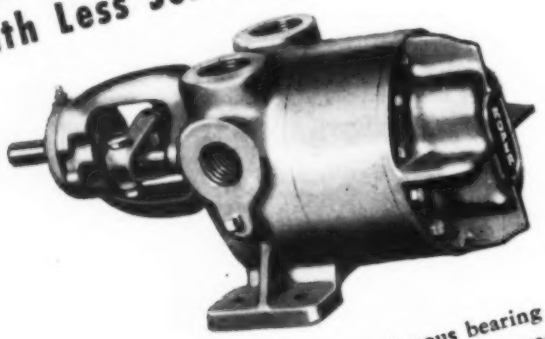

Roper Pumps have positive, continuous bearing lubrication. The liquid pumped enters grooved bearings from the pressure side and is drawn to the suction side through grooves in the opposite bearings.

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Floating equal size external gears, supported at both ends with high-grade bronze bearings, and choice of packed box or mechanical seal units to suit individual job requirements, efficient operation in either direction, easy accessibility to working parts cuts down "out-of-service" time. Four-port design offering eight optional piping connections cuts installation time and cost. Four piping arrangements are possible with pump operating clockwise . . . four other arrangements with pump operating counter-clockwise.

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ROPER Rotary Pumps

GEO. D. ROPER CORP., 701 Blackhawk Park Ave., Rockford, Ill.

LETTERS to the Editor

We have a FWD truck, in use on highway work, which pulls a trailer with a turntable capable of handling an approximate weight of 12 tons. We would like to equip the truck itself with hydraulic steering and a hydraulic motor for operating the turntable. I would like to contact a hydraulic equipment concern that could build or supply such equipment.

H.T.S.

The names of several manufacturers of hydraulic steering equipment and of both cylinder and motor combinations have been forwarded.

Would like your comments as to the practicality of the following problem. We have numerous small standard air arbor presses (single actina spring return cylinder, 3 in dia by 3 in stroke) which we wish to convert, if possible, into a riveting setup with the following sequence: (1) load work; (2) piston down (two hand control for safety); (3) riveting stroke (rate of 2-3 per second, more if practical, with the number of strokes adjustable); with travel sufficient for some impact force; (4) ram retract; and (5) unload or reject of work.

We realize the drawbacks of the spring return for any appreciable speed and the large volume of air required by the 3 in cylinder, which would reduce the speed considerably. However, we would appreciate your comments and, if possible, a workable schematic diagram.

A.W.K.

This is a problem for an air equipment engineer. We are sending your request to several organizations that specialize in this type of work. We are publishing the letter as an open invitation to those of our readers who may wish to comment or make suggestions.

We are interested in sending one of our young engineers to a good short training course on hydraulic maintenance. We are grooming him for a new job as maintenance supervisor. We would prefer a factory training plan but would consider a special course to fit the requirements, if such is offered by a technical school.

J.N.

We are sending you the name of one company that has a short training course that might fit your requirements. There are several others that might be interested in taking in your man and permitting him to work in the shop or in the field to acquire the specific training he needs. Have you inquired of your own major sources of supply?

This column is open to comments on general trade and technical problems. Comments are invited from our readers on questions or answers as published—EDITOR.

BROWN & SHARPE MFG. CO.

GRINDING MACHINES

Brown & Sharpe Manufacturing Company, pioneer and leading manufacturer of machine tools, pumps, accessories and machinists' tools, has incorporated hydraulic circuits in two of their widely used grinding machines. The data herewith has been supplied by this company as an additional service to the maintenance personnel of the plants in which these grinders are in operation.

No. 5 Surface Grinding Machine

For efficient production of accurate flat surfaces where precision, fine finish and rapid removal of stock are of equal importance.

Hydraulic Circuits: Longitudinal and transverse table feeds.

Attachments Available: Specification Catalog.

Operation, Service and Parts Manual: Operation and Maintenance Booklet (Including Repair Parts).

Proper Care and Operation: Operation and Maintenance Booklet.

SPECIFICATIONS	
style	**surface**
grinds work to—length	24 in
width	8 in
height	11 in
work table—length	67 in
width	11¾ in
speeds—wheel, rpm	2300
table travel (infinite)—longitudinal	to 60 fpm
transverse	to .25 in at each reversal
grinding wheel used—straight	10 in diam, ¾ in thick, 3 in hole
motor drives—grinding wheel	1½ hp
hydraulic pump	¾ hp

GRINDING MACHINES

Nos. 10 and 12 Plain Grinding Machines
Electric-Hydraulic Type
6 and 10 in Swing

Designed for rapid cylindrical grinding of small and medium-sized parts to close limits on a production basis. Many parts can be ground to .0001 in tolerance with consistent uniformity on ground diameters to 3 in at maximum production.

Hydraulic Circuits: Longitudinal table travel and cross feed.

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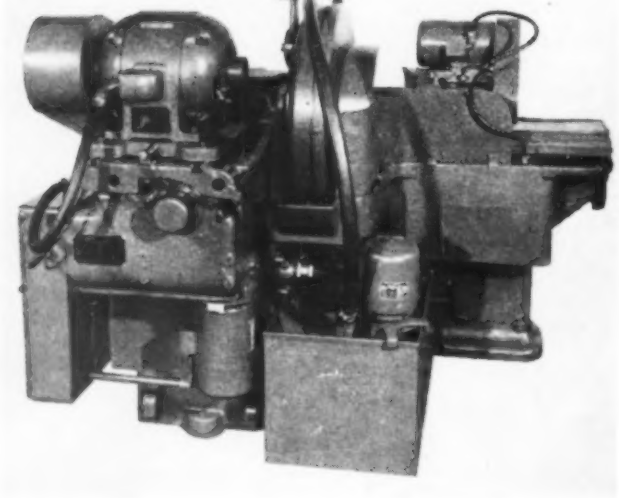
Proper Care and Operation: Operation and Maintenance Booklet.



SPECIFICATIONS

style	plain
centers take length—no. 10 machine	18 in
no. 12 machine	30 in
centers swing over table, diam— 6 in machine	$6^{11}/_{16}$ in
10 in machine	$10^{7}/_{8}$ in
24 in wheel grinds work to	4 in diam
speeds—wheel, rpm	1030 and 1240
Work, rpm	97 to 383
table travel (infinite)	7 to 360 in/min
grinding wheels used—straight	to 24 in diam, $1\frac{1}{2}$ in to 4 in thick, 12 in hole
recessed (type 7)	to 24 in diam, $2\frac{1}{4}$ to 4 in thick, 12 in hole
motor drives—grinding wheel	$7\frac{1}{2}$ hp
headstock	$\frac{1}{4}$ hp
wheel slide rapid travel	$\frac{1}{4}$ hp
hydraulic pump—no. 10 machine	$\frac{1}{3}$ hp
no. 12 machine	$\frac{1}{2}$ hp
coolant pump	$\frac{1}{2}$ hp

Copies of Specification Catalogs and Operation and Maintenance booklets will be furnished upon request by Brown & Sharpe Mfg. Co., Providence 1, R. I. While copies of pertinent literature on maintenance are regularly furnished to purchasers of machines, additional copies will be furnished to supervisory and service maintenance personnel. Please give model of machine when requesting literature. Specify attachments, if any, being used.

All Brown & Sharpe machines, attachments and accessories are protected by issued and pending United States and foreign patents.

The Fifth of a Series of Articles on Air Circuit Design

AIR CIRCUIT FOR FURNACE CONTROL

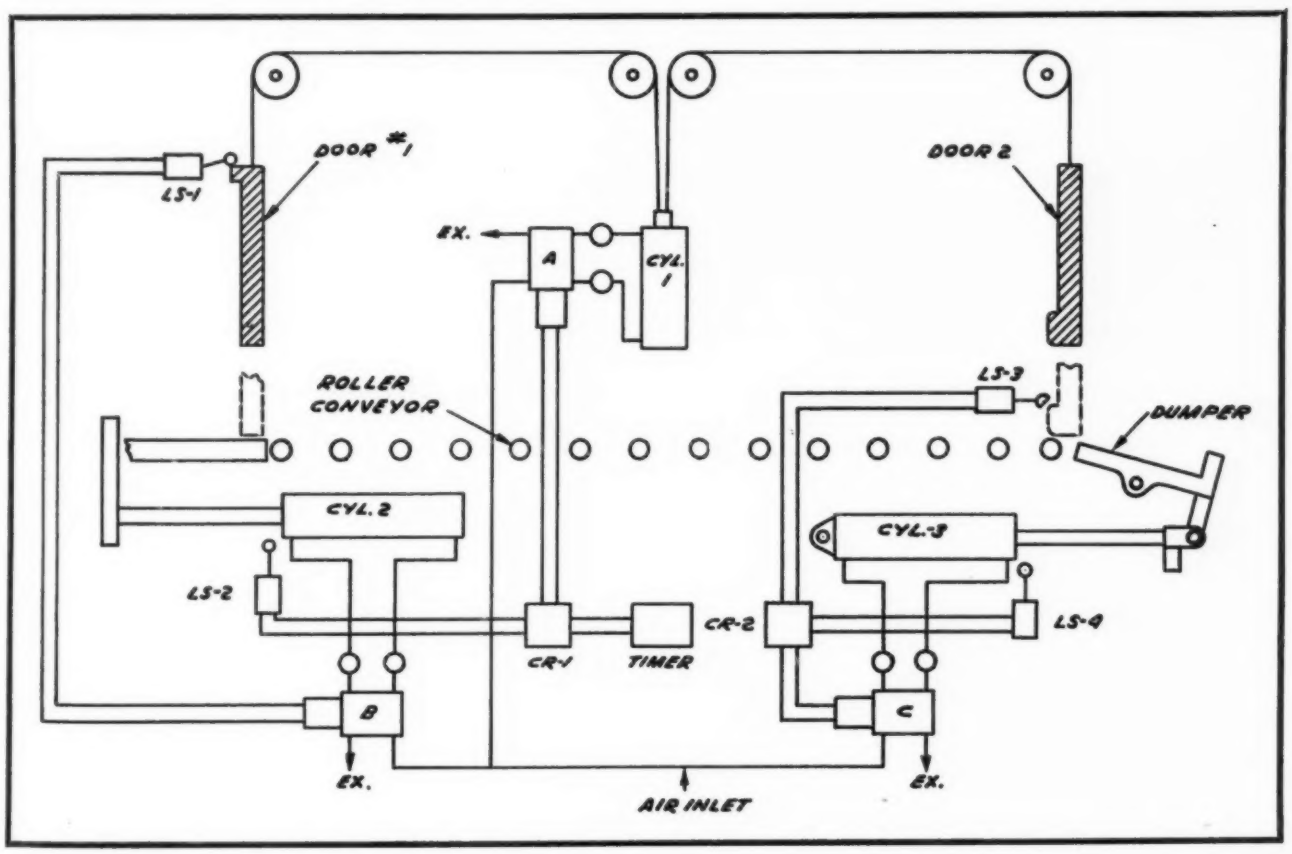
By W. J. SCHUPNER
Design Engineer
Chicago, Illinois

AN INTERESTING APPLICATION of air controlled operation is shown in the "Air-Draw Furnace" for annealing grey iron castings. The system, with cylinders operated by solenoid actuated, spring return 4-way air valves, is controlled through a timer, open and closed limit switches, speed control valves and relays. Such a circuit has a wide range of application possibilities for many industrial uses.

The photograph, Figure 2, illustrates this type of furnace. A gravity roller conveyor runs through the entire length. Metal baskets, loaded with the castings to be heat treated, are pushed, at timed intervals to opposite end where a "basket dumper" discharges the cast-

(Continued on page 27)

Fig. 1. Schematic arrangement of the air and electrical circuits for automatic cycling.



New PRODUCTS

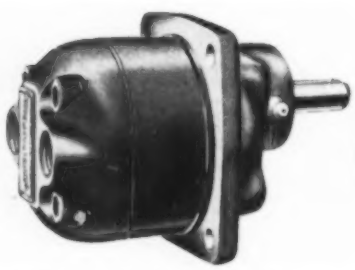
For additional information on any of these products, mark the end key numbers on the card bound in this issue and mail the card.

Air Check Valve

Greer Hydraulics, Inc. announces a new air check valve especially designed to answer requests for a more efficient air valve for accumulators. This valve provides a positive seal against gas leakage from the separator bag. It consists of a valve body enclosing a poppet, spring and plunger and can also be used as a bleeder valve. Although designed for use with Greer accumulators, this valve can be used in any high pressure gas vessel. Use Business Reply Card, mark NP-1.

Four-Bolt Gear Pump

The Hydraulic Equipment Company recently announced its new 100 series Hydreco Four-Bolt Oil Hydraulic Gear Pump. This series, designated



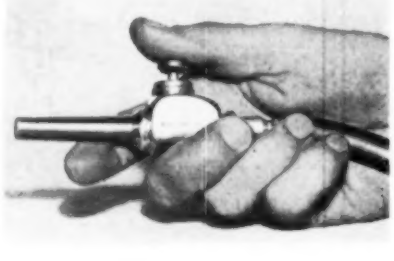
particularly for applications with rigid space requirements and in which low volumes are required, incorporates the same basic design as the heavy-duty industrial unit made by this company. The new pump is the first of a series of oil hydraulic gear pumps with the Hydreco Four-Bolt design of assembly. This design employs only four assembly bolts located within the area of greatest stress and eliminates the multiplicity of assembly bolts or cap screws outside the stress area, typical of the conventional design of gear pump. The new 100 series pumps are available in ratings from 2.25 to 4.5 gpm, delivery at 1000 psi and furnished with either flange or foot mountings. Use Business Reply Card, mark NP-2.

Self-Flaring Fitting

A new self-flaring tube fitting consisting of two pieces, body and nut, is announced by Scovill Manufacturing Company. The body contains the flaring cone and the nut contains the thrust collar; there are no other parts. Only three steps are required to connect it. These fittings are offered in annealed steel, aluminum and monel in sizes ranging from $\frac{1}{8}$ to $\frac{5}{8}$ in. Use Business Reply Card, mark NP-3.

Air Valve

A new general-purpose air hose valve and nozzle with no springs or packing is announced by Paul Valve Corporation. The new valve is for any air line up to 100 psi. Springs are eliminated by utilizing the Bernoulli Theorem, a stainless steel ball is forced into the high velocity air stream, thence into the seat. Seal is provided by positive, packless "O" ring. The new valve is available for $\frac{1}{8}$ and $\frac{1}{4}$ in hose sizes, both with bodies tapped for standard $\frac{1}{4}$ in pipe threads. Use Business Reply Card, mark NP-4.



Bellows Seals

The Garden Manufacturing Company announces a simple, practical fool-proof seal for excluding dirt from shafts used on pushers, lifters, locators and machine ways. They are available in shaft sizes ranging from $\frac{1}{2}$ to 6 in and are recommended for use where expansion of not

over 1 in per convolution is encountered. These "accordian" seals are lubricant retaining, they introduce no added friction and, for the first time, are available from stock. Use Business Reply Card, mark NP-5.

Oil Purifier

The De Laval Separator Company offers the "Uni-Matic", a complete oil purification unit consisting of an oil purifier plus all necessary pumps, heaters, electrical controls and auxiliary equipment, all compactly mounted on a base. It is furnished in two types: (1) Purifier with pumps; (2) Purifier with pumps and automatically controlled heater. Each can be supplied in four sizes and in portable arrangements if desired. Use Business Reply Card, mark NP-6.

Heat Exchangers

A redesigned line of standardized heat exchangers is announced by Ross Heater & Mfg. Co. The mass produced "BCF" exchangers are offered at lower unit cost and are available from stock. The new exchanger is recommended for oil and water cooling applica-

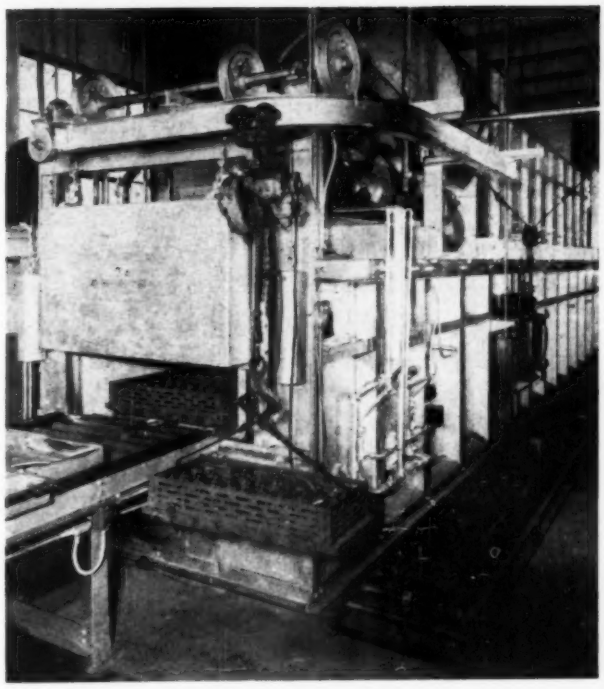
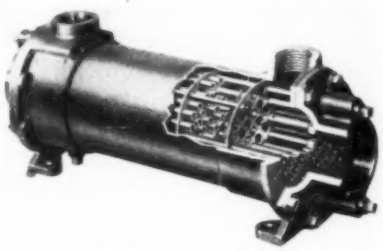


Fig. 2. The receiving end of the annealing furnace. The air cylinder, sheaves and cable that operate the doors are shown. The loading cylinder is under the roller conveyor at the left.

tions on hydraulic presses, couplings, torque convertors, pumps and compressors.



Single, two- and four-pass models are offered in sizes from 2⅛ to 8⅛ in. This design incorporates transverse baffling of the cooling medium across the tubes. Use Business Reply Card, mark NP-7.

Compressed Air Conditioner

A new and radically improved combination unit for conditioning compressed air has been developed by Hannifin Corporation. This unit, consisting of an air filter, pressure regulator and lubricator, was designed for conditioning air for use in tools, cylinders and other air powered equipment. The filter uses micronic edge filtration, the regulator incorporates a "free floating" valve stem and the lubricator is designed to operate at pressures to 150 psi. Use Business Reply Card, mark NP-8.

AIR CIRCUIT FOR FURNACE CONTROL

(Continued from page 25)

ings onto a conveyor for cooling. The baskets are then refilled and returned to their starting point along the outside roller conveyor which is parallel to the furnace. An electric hoist, traveling on a monorail at each end of the unit, serves to place the loaded basket onto the main conveyor at the receiving end and to remove the empty one from the "dumper" at the discharge end. With the exception of the hoisting procedure the operation is completely automatic.

Figure 1 shows the schematic arrangement of the air and electrical equipment which serves to control the continuous cycle.

Details of Cycle Operation

Assume that the doors at each end of the furnace are closed, proper temperature has been attained and that a basket of castings is ready to be admitted. The timer closes relay CR-1, which energizes the solenoid on spring return 4-way air valve "A", directing the piston of cylinder No. 1 down. Flexible steel cables attached to the end of the piston rod, pass over sheaves and draw the counterweighted doors upward. Door No. 1 contacts normally open limit switch LS-1 which energizes the solenoid on 4-way spring return valve "B", directing the piston of cylinder No. 2 to the right and pulling the loaded basket of castings into the furnace.

The draw bar, on reaching the end of its stroke, contacts normally closed limit switch LS-2, breaking the holding circuit in CR-1 which reverses valve "A". The doors start to move down. Door No. 1, on moving away from LS-1, de-energizes the solenoid on valve "B" and the piston on cylinder No. 2 returns to the left. Note that the speed of piston No. 1 must be timed by speed control valves to permit the draw bar on cylinder No. 2 to properly clear the descending door.

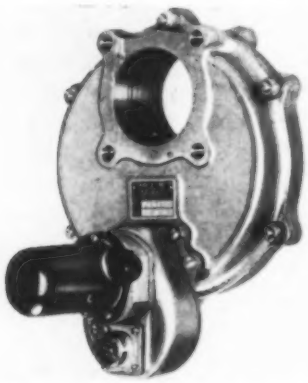
The above cycle of operations is repeated at intervals governed by the setting of the timer. Eventually, the entire length of the furnace conveyor will be loaded with baskets of castings so that each time a basket is pushed in by cylinder No. 2, another is also pushed out at the far end onto the basket dumper.

As door No. 2 rises, it bypasses limit switch LS-3. However, on descending, it trips and by-passes LS-3, thus closing relay CR-2 and energizing the solenoid on valve "C", which causes cylinder No. 3 to operate the dumper. The dumper has a clamping device which, as cylinder No. 3 operates, automatically clamps the basket and holds it in place while it is being tilted. A dog attached to the dumper contacts normally closed switch LS-4 on its return, breaking the holding circuit in CR-2 and returning the dumper to its original position.

In air cylinder applications of this nature, it is customary to furnish special piston and rod packings to withstand the high ambient temperatures.

Motor Operated Shut-Off Valve

A new "Shear-Seal" motor operated fuel shut-off valve, featuring high capacity and controlled actuation, is the latest offering of Saval, Inc. Designed especially for rapid refueling in flight, it is also suitable for single point refueling systems. With clean, straight-through flow passages and no declivities to cause turbulence, the unit is available in five sizes from 1¼ to 3½ in tube sizes. Actuator is 22-28 v dc, rated load current is 1.8 amps at 24 v. The valves are adaptable for hydraulic, water, oil and hot air as well as aromatic fuel. Use Business Reply Card, mark NP-9.



Fire-Resistant Fluid

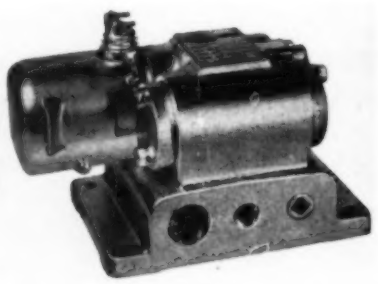
Development of a new fire-resistant hydraulic fluid has been announced by Monsanto Chemical Company. The new fluid is described as a synthetic liquid combining most of the desirable characteristics of existing hydraulic fluids with high fire-resistant qualities. The new fluid, Skydrol, has a high viscosity index — with little change of viscosity over a wide temperature range — and good lubricity. This ensures extended pump life. Use Business Reply Card, mark NP-10.

Tube Fitting

A new tube fitting, "Triple-lok", developed to meet the new standards set for hydraulic circuit connections on production machinery, is announced by The Parker Appliance Company. This new fitting is made in steel with dryseal threads and with 37 degree flare angle. It will be identified with black nuts and sleeves and cadmium-plated body and will be offered to accommodate the complete range of tubing wall thicknesses. Use Business Reply Card, mark NP-11.

Air Valves

A new line of solenoid operated air valves embodying many new features has been announced by Viking Products Company, Inc. These valves,



designed for operation with 110 ac current and air to 105 psi, are available in 3-way or 4-way types and sizes to ¾ in. They are direct acting and positive in operation; they require no complicated pilot valve arrangement. A single interchangeable and quickly replaceable valve assembly is used in all models. Use Business Reply Card, mark NP-12.

Hydraulic Accessory

The Denison Engineering Company has available a multi-purpose, oil-hydraulic press of 2000 lb capacity, complete with its own pumping equipment. This completely packaged unit is very versatile and can be rapidly switched from one machine set-up to another. It can be adapted to other hydraulic machinery and can be operated in any position. The ram stroke is 6 in and the speed is 600 ipm up and 400 ipm down. Use Business Reply Card, mark NP-13.

Useful Literature

The publications listed are available without charge. Mark the initial key number on the card bound in this issue and mail.

25. Air Cylinders . . . The entire line of Gerotor double acting, non-rotating air cylinders is illustrated and described in the new Catalog Section No. 53 just published by Gerotor May Corporation. Directed toward helping the design engineer, this 16-page bulletin contains drawings and tables giving complete detailed dimensions for each model and size cylinder. A complete line of mountings featuring special tie rod-eliminating features with self adjusting rod and cup packings are offered.

26. Gasket and Sealing Materials . . . A 20-page booklet describes the physical properties and sealing applications of cork, synthetic rubber, cork-synthetic, cork-rubber, fiber and felt materials made by the Armstrong Cork Company. Tables of various compositions, sizes and forms and government specifications for Army, Navy and Aeronautical applications are given. There is an excellent section on the selection and use of resilient sealing materials with design drawings, deflection and load-compression curve charts. Finally, a 2-page chart of gasket recommendations is included.

27. Fluid Power Pumps and Motors . . . Bulletin 47000, issued by The Oilgear Company describes the fluid power variable and constant displacement pumps and motors made by this company. With technical data, dimensional drawings and representative applications integrated for easy reference, the 54-page booklet offers many de-

(Continued on page 31)

Applied HYDRAULICS DIGEST

Abstracts, summaries and listing of articles on hydraulic and associated applications in industry; reports on prepared papers, talks and discussions of special interest to the hydraulics field.

Hydraulic Seals

Frank Flick, *Machine Design,* v 20, November 1948, pp 139-144.

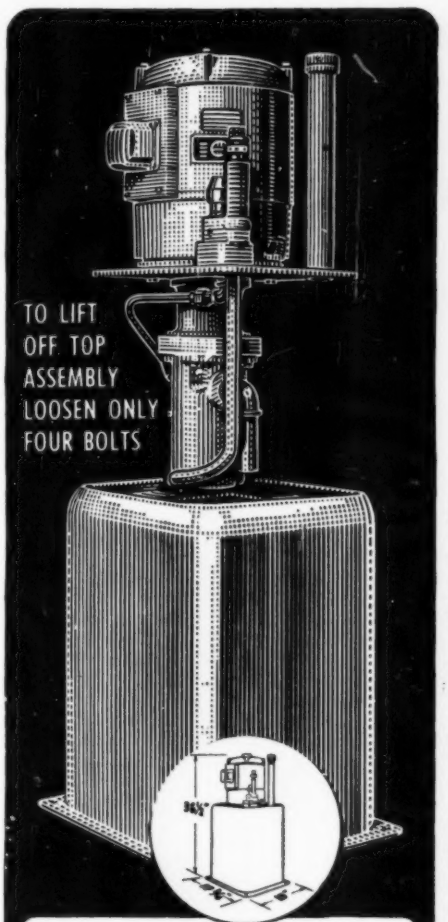
A review of the factors to consider in selecting sliding types of seals. The seal "represents the hub of the hydraulic cylinder problem. Much thought, skill and experimentation have been put into its development." Experience suggests that no one type of piston or piston rod seal is best for all applications, the type selected should be determined by the benefits chiefly desired in each application. The characteristics and advantages of the standard types of metallic and nonmetallic piston seals are discussed and illustrated in a useful table. Leakproof operation is the result of correct design of all components of the sealing assembly rather than that of the seal alone. Static seals are treated briefly. The author urges the utilization of all types of available seals, the selection being based in each case on specific requirements of the job in hand.

Hydrodynamic Transmissions

John F. Swift, address before the American Gear Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill., October 27, 1948.

Mr. Swift of the Engineering Research Department, Engineering Division, Ford Motor Company, illustrated the advantages of the torque converter principle by an analysis of a simple, three element hydrodynamic transmission, and pointed out the differences between the mechanical gear system, which is a constant speed ratio system, the fluid coupling, which is a constant torque ratio system and the torque converter, which is a variable torque ratio system. He showed by diagrams and charts how the torque ratio and efficiency curves for a hydrodynamic transmission may be designed for a considerable variety of characteristics, including

Extra *Compactness* in Denison Pumping Units for Every Hydraulic Need



SPACE-SAVING VERTICAL MOUNTING FULLY SELF-CONTAINED
including
Relief Valve
Oil Level Gauge
Electric Motor
Oil Reservoir
Hydraulic Pump
Oil Cooler
Pressure Gauge

SPECIFICATIONS

MODEL	GPM @ 0 PSI	MAX. PUMP PRESSURE	MOTOR
PUG2	2	1000 psi	1½ hp 1800 rpm
PUG3	3.5	1000 psi	1½ hp 1800 rpm
PU3	3.5	2000 psi	3 hp 1800 rpm
PUF3	3.5	2000 psi	5 hp 1800 rpm
PUV5	5	1000 psi	3 hp 1800 rpm
PUF7	7.25	2000 psi	5 hp 1800 rpm
PUS7	7.25	2000 psi	7½ hp 1800 rpm
PUV7	7.5	1000 psi	3 hp 1800 rpm
PUFV7	7.5	1000 psi	5 hp 1800 rpm
PUF9	9	2000 psi	5 hp 1800 rpm
PUS9	9	2000 psi	7½ hp 1800 rpm
PUV11	11	1000 psi	3 hp 1800 rpm
PUFV11	11	1000 psi	5 hp 1800 rpm
PUSV11	11	1000 psi	7½ hp 1800 rpm

Packaged power is at its best in these compact and completely self-contained DENISON hydraulic pumping units. They feature an advanced type of vertical assembly — which simplifies their construction, lowers their cost, makes them far more rugged and easier to service. Just loosen *four bolts* and the whole top assembly, including electric motor, hydraulic pump, pressure relief valve, piping and mounting plate, can be lifted off of the reservoir as a single unit! These efficient pumps provide a range of pressures up to 2000 psi; volume output ranging from 1.5 to 11 gpm. *Write for details!*

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An Oilfoil washer or seal is a sandwich of felt and Hycar, the synthetic elastomer that is especially resistant to oils, hydraulic fluids and hydrocarbons. The felt serves both for sealing and as a lubricant reservoir; the Hycar as an impervious barrier. Here is the ultimate in protection. Write on your letterhead for full information.

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GENERAL OFFICES: GLENVILLE, CONN. Engineering and Research Laboratories: Glenville, Conn. PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal

the size factor "K" and its application to overall performance. He pointed out that with a given hydrodynamic transmission and a given power source it is possible to obtain wide differences on the overall performance of the power train by various combinations of gearing systems. He discussed relative advantages of gearing placed after the hydrodynamic transmission and between the power source and the transmission. He concluded that to achieve the maximum results with a hydrodynamic transmission, it is usually necessary and desirable to use mechanical gearing in conjunction and that the use of gearing is frequently necessary to achieve the desired overall performance characteristics. The hydrodynamic transmission actually broadens the field of transmissions and can increase the use of gears rather than decrease or replace their usage.

Master Bases Cut Fixture Costs

Herman Goldberg, *American Machinist,* v 92, December 2, 1948, pp. 83-90.

In this special report to the Metal Working Industries, Mr. Goldberg discusses the introduction and application of standard master bases for jig bodies that must be specially built. Both cam-lock and air operated models are shown. Most of the bases are designed for operation by compressed air. Drawings and setup photographs offer many excellent application ideas.

VACUUM *SPEEDS CHUCKING*

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GAST ROTARY PUMPS

HOW TO HOLD ODD-SHAPED PIECES IN SPEED LATHE

Problem: Cut chucking time and boost production on speed lathe used for polishing.

Solution: A Gast Rotary Vacuum Pump supplies quick, positive vacuum needed for chucking. Rating, 17 c.f.m.; Vacuum to 27".

RESULT: Faster chucking on this Gast-equipped machine.

This is but one example. Over 200 variations of basic Gast units now serve as original components on scores of products. In totally *unrelated* fields, Gast Air Motors, Vacuum Pumps and Compressors are proving their unique advantages. Perhaps *you* can use them to help on a new application. Write now for details.

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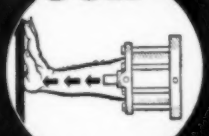
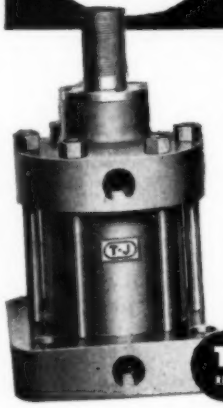


You can **SAVE LABOR** *with* **T-J CYLINDERS**



Why waste labor on "muscle jobs" of pushing, pulling, lifting or control operations? T-J Cylinders will do it *automatically . . . with accuracy . . .* and *cut costs!*

For 100 lb. or 50,000 lb., there's a T-J Air or Hydraulic Cylinder that's *right* for your requirements. Many standard sizes and styles . . . both cushioned and non-cushioned types. Precision-built . . . backed by 31 years of know-how . . . dependable. Write for catalogs. The Tomkins-Johnson Co., Jackson, Michigan.

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RIVETORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHORS

USEFUL LITERATURE

(Continued from page 28)

sign and installation suggestions valuable to the application, production and operating engineer.

28. Dow Corning Silicone Note Book . . . This handsome 32-page booklet describes the properties and behavior of the DC 200 silicone fluids produced by the Dow-Corning Corporation. These semi-inorganic fluids are notable for their heat stability, shear resistance, relatively constant viscosity over a wide range of temperature, lubricity, water repellency and good dielectric properties. Their usefulness as damping and hydraulic media, special purpose lubricants or as additives or coatings is established. Tables, graphs and text combine to give a very comprehensive body of information.

29. Air Clutch Catalog . . . Fawick Airflex Catalog No. 300 gives full engineering and application data on the complete line of air clutches made by this company. The 32-page catalog also has tables on service factors and service ratings.

30. Hydraulic Pumps . . . Lyon-Raymond Corporation producers of a line of foot- and hand-operated hydraulic pumps, review them in Bulletin 250. The hand-operated pumps are available in two speed, double acting, 4-piston units for operation at pressures to 2500 psi and the foot-operated pumps are offered in single-and two-speed units. The single-speed units reach 3000 psi and the two-speed units 10,000 psi. Design drawings and specifications completely describe these units.

31. Engineering with Sirvene . . . A 32-page brochure, offered by Chicago Rawhide Manufacturing Co., is devoted to characteristics and properties of Sirvene compounded elastomers and their application to the engineering of new products. Of special interest are several case histories involving the design of a hydraulic accumulator diaphragm and of a pump diaphragm and the last chapter, composed of a series photographs of mechanical parts made of Sirvene. Excellent illustrations are used throughout.

32. Air and Hydraulic Cylinders . . . Hydro-Line Manufacturing Co. are now offering a complete line of air cylinders and low pressure hydraulic cylinders. They are offered in six conventional, standard mounting types with bores ranging from 1½ to 14 in. Catalog A-48 is devoted to air cylinders and catalog H-48-LP covers the low pressure hydraulic cylinders. Both catalogs are profusely illustrated with design and cut away drawings plus complete dimension charts.

33. Oil Power Fluid Motors . . . An 8-page bulletin, Form No. 113, offered by Sundstrand Hydraulic Division, Sundstrand Machine Tool Co., describes and pictures the line of single and double piston types of fluid motors made by this company.

PROTECT HYDRAULIC MACHINES
Where Trouble STARTS!

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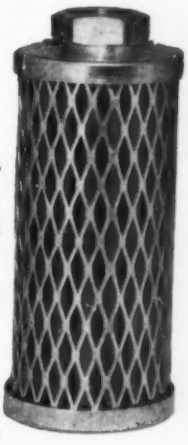
A **MARVEL SYNCLINAL FILTER**
AT THE INTAKE OR SUCTION SIDE OF THE PUMP

Marvel Synclinal Filters are your safeguard against costly breakdowns occurring from pipe scales, dirty oil, and other harmful matter which clogs the fine tolerance valve openings. Why gamble with equipment worth thousands when you may MARVELIZE your hydraulic equipment at a cost that will prove insignificant compared to the price of a jammed or wrecked hydraulic circuit costing thousands.



2½ TIMES MORE FILTERING AREA THAN EQUIVALENT SIZE CIRCULAR TYPE FILTERS.

This means maximum filtration in less space. Standard 100 mesh (.0050 opening) insert—others range from coarse 30 mesh to fine 200 mesh inserts. Adaptable to meet any filtering problem.

SUMP TYPE IN 6 CAPACITY SIZES—5 PIPE SIZES.

—5, 8, 10, 30, or 50 gal. per minute. In increased capacity easily obtainable with manifold installations.

Write for Catalog No. 103 containing complete engineering data.

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POST SCRIPTS OF INDUSTRY

NEWS · VIEWS · TRENDS

Plastic and Rubber Products, Inc., "O" ring specialists, have moved their Chicago office into new and larger quarters at 400 W. Madison St. The office is under the direction of Robert E. Allen, vice president in charge of sales.

Pesco Products Div. of the Borg-Warner Corporation, has opened a Chicago sales office at 231 LaSalle St. J. D. Campbell will be in charge.

Larry Gardner, president of Airmatic Valve, Inc., Cleveland, announces the appointment of the Nilsen Engineering Co., 101 Washington St., Salem, Mass., as exclusive representatives in the six New England states.

Hydro-Line Manufacturing Co., Rockford, Ill., has appointed C. M. Murray, Ltd., 306 Foy Building, Toronto, Ontario as exclusive representatives for this company's line of air and hydraulic cylinders and special machinery in the provinces of Ontario and Quebec.

Linear Inc., Philadelphia manufacturers of precision moulded rubber products and mechanical packings, has appointed R. M. Zimmerman as sales and engineering representative in the midwest territory. Mr. Zimmerman will cover the states of Oklahoma, Texas, Missouri, Kansas, New Mexico and Arkansas with headquarters in Tulsa, Okla.

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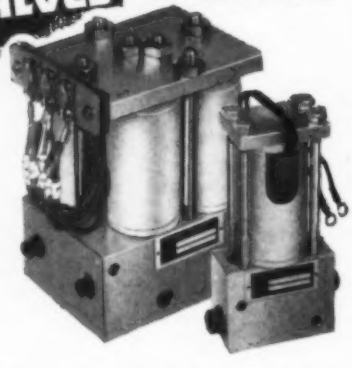
NEW HIGH PRESSURE
SOLENOID VALVES

- TWO-WAY
- THREE-WAY
- FOUR-WAY
- NORMALLY-OPEN
- NORMALLY-CLOSED



Features

- Rugged Compact Construction
- 3000 psi operating pressure
- May be mounted in any position
- Poppet design eliminates leakage
- Low current consumption
- Impregnated coils resist moisture and condensation

Waterman High Pressure Solenoid Valves are compact units that provide controls for hydraulic systems with pressures as high as 3000 psi. Poppet type construction eliminates leakage thereby making them ideal for clamping and holding cylinders or any other hydraulic application where internal leakage cannot be tolerated.

Available in ¼" and ⅜" pipe size—any voltage from 6 to 36 volts D.C.

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